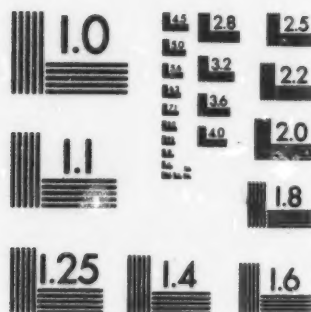


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**LABOUR AND THE LOCATION OF
HIGH TECHNOLOGY INDUSTRY: SOME
PROSPECTS FOR BRITISH COLUMBIA**

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PROSPECTS FOR BRITISH COLUMBIA**

by

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The views expressed in this paper are solely those of the author, and not necessarily those of the Ministry of Universities, Science and Communications.

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Any errors, of course, remain the responsibility of the author.

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INTRODUCTION

Recent studies of the Canadian experience with the establishment and development of high technology industry seemed to have centred around three major themes: the technology or R&D gap between Canada and other OECD countries,¹ the displacement of labour by technology (technological unemployment),² and the shortage of highly skilled manpower.³ Up to now, the literature has generally been silent on what major factors determine the location of a particular high technology industry in a specific country or region, with the general exception of observations that the high technology sector is "foot-loose" and not bound by usual physical constraints on the location of industries (e.g., raw materials, transportation facilities).

At this time in Canada, however, all levels of government are competing through a myriad of programs to attract high tech to their particular area or region. British Columbia's advanced technology enhancement program provides start-up funds for new companies, and rents space for research and manufacturing in its Discovery Parks sites. Notwithstanding these provincial incentives, British Columbia is still viewed by many as a poor place to locate because of the high degree of unionization of the labour force, restrictive labour legislation and high prevailing wage rates.

In a recent interview, Dr. Patrick McGeer, the British Columbia Minister of Universities, Science and Communications said, "Our difficulty is we're renowned for unreliable labour and for work stoppages. We've got the worst reputation in Canada,..."⁴ Moreover, the Minister has claimed that British Columbia's poor labour relations image resulted in the loss of three potential microelectronic plants.⁵

Similar comments are heard from industry members. At a recent meeting of the Urban Land Institute, a member of the U.S. industry suggested that "exempting high technology industries from the provincial labor code would be a 'very major help' in attracting research facilities to B.C." "U.S. research firms," continued the commentator, "are 'paranoid' about being unionized."⁶

Statements such as these would seem to indicate that the degree of unionization of labour and its effect on wages and labour relations, are the overwhelming determinants of the location of high technology industry. As mentioned above, the literature in Canada has generally overlooked locational studies of high technology industries;⁷ thus, at least for the Canadian experience there is no empirical evidence to support the view that labour unionization and/or labour costs are the prime factors. However, labour in British Columbia is still seen by many as the prime obstacle to the development of high technology

industry in the province, and to diversification of our resource-based economy.⁸ British Columbia of all regions in Canada, therefore, has the greatest stake in the outcome of any empirical study of locational factors.

This study attempts to fill the gap between generalized statements on the role of labour in locational decisions and the scattered empirical evidence available mostly from the U.S. literature. It is, if anything, a plea for more empirical research into the real factors in Canada since one is always in danger of translating the American experience directly into ours.

The study is organized into three chapters. Chapter I presents a summary of the major U.S. study on the location of high technology firms. The study prepared for the Joint Economic Committee of the U.S. Congress surveyed nearly 700 U.S. companies for their ratings of the factors influencing locational and expansion decisions. In addition, the small evidence from Canada is summarized. Chapter II provides an in-depth look at labour in high technology industries in Canada and the U.S. It examines the skill structure of the labour force, shortages and wage rates, and the role of education and training. The trend for high technology companies to locate in low-wage countries is also reviewed.

Finally, chapter III presents some prospects for the future. The increasing competition between states, regions and governments for high tech industry is analyzed against a background of increasing worries about labour displacement and competition from the Third World. Public policy issues are reviewed, and some recommendations for further research are also put forward.

The Appendix contains a brief review of a recent study comparing locational criteria of U.S. and Japanese companies.

CHAPTER I

LOCATIONAL DETERMINANTS OF HIGH TECHNOLOGY INDUSTRY

United States

The Joint Economic Committee Study

In June 1982, the Joint Economic Committee of the U.S. Congress published a staff study entitled Location of High Technology Firms and Regional Economic Development.¹ Congressman Clarence J. Brown said in his Foreword to the paper that although high technology companies were viewed as the salvation of those regions in the U.S. suffering severe economic decline, little was known about the industry -- particularly about those factors which determine where companies locate their plants and facilities.² This lack of information and the gap in the literature on economic development were also raised by the study's authors who noted:

These three prominent high technology centers [Silicon Valley, California, the Highway 128 area in Boston, Massachusetts, and the Research Triangle Park in North Carolina] have been the subject of a voluminous popular literature, primarily in newspapers, business magazines, and trade journals, but strangely they have received little scholarly attention. The literature is based primarily upon these studies and expert opinion rather than evaluating systematically organized data on the expansion and location of high technology companies in these areas and the problems they face.³

The JEC staff designed a survey questionnaire in which firms were asked to rank all likely factors obtained from an earlier review of the literature as possible locational determinants.⁴ Companies were also asked about plant expansion plans, and in what region(s) expansion would most likely take place. Factors which distinguish locations within regions were also ranked.

The questionnaire was mailed to 1,750 companies; 691 responded. The product mix of the responding companies is shown in table 1.

TABLE 1
TYPE OF PRODUCTS OF RESPONDENTS TO SURVEY
ON REGIONAL LOCATION CHOICES
OF HIGH TECHNOLOGY COMPANIES

	Response
Semiconductor	29.5%
Telecommunications	12.8
Research	9.4
Aerospace	8.5
Chemical	2.8
Medical Instruments	7.6
Other ^{1/}	32.0
Total	100.0%*

^{1/} Respondents most frequently listed computer related products, specialized measuring instruments, and advanced guidance systems.

Source: JEC, Location of High Technology Firms,
p. 20, table III.1.

*Does not add to 100.0%. Source of discrepancy in original table unknown.

Table 2 presents the survey results for the locational factors assumed to determine choice of a region.

TABLE 2

FACTORS THAT INFLUENCE THE REGIONAL LOCATION
CHOICES OF HIGH TECHNOLOGY COMPANIES

Rank	Attribute	Percent Significant or Very Significant ^{1/}
1	Labor skills/availability	89.3
2	Labor costs	72.2
3	Tax climate within the region	67.2
4	Academic institutions	58.7
5	Cost of living	58.5
6	Transportation	58.4
7	Access to markets	58.1
8	Regional regulatory practices	49.0
9	Energy costs/availability	41.4
10	Cultural amenities	36.8
11	Climate	35.8
12	Access to raw materials	27.6

^{1/} Respondents were asked to rate each attribute as "very significant, significant, somewhat significant, or no significance" with respect to their location choices. The percent of very significant and significant responses were added together to obtain an index of overall importance.

Source: JEC, Location of High Technology Firms,
p. 23, table III.5.

Labour skills and availability received the highest score of 89.3 percent (66.1 percent very significant and 23.2 percent significant). The availability of these skills is considered to be more important than their cost, although labour costs ranked second.

The JEC survey was also designed to separate out factors which influence choice of a particular region from factors influencing choice of a particular location within a region.⁵ The survey results are presented in table 3. The authors suggested that the high ranking given to the availability of skilled technical workers may result from the difference in mobility rates between technical workers and professionals (scientists and engineers.)⁶

The survey also compared the current distribution of the plants and offices operated by the 691 respondents with their planned distribution by region over the next five years. The results confirmed what had already been observed in the industry — a spatial dispersion of companies away from the Silicon Valley and Route 128 areas to the Midwest, Southeast, Mountain and Plains States.⁷ Labour costs, land costs, congestion, and high taxes all have contributed to this movement.

These findings also confirmed in the authors' opinion a trend to regional specialization, as the mature new industries seek low-cost regions for their production facilities while maintaining their R&D facilities in more technologically advanced regions.⁸ The implications of this trend, including the moving of production facilities to Third World countries, will be discussed further in chapter III.

TABLE 3

FACTORS THAT INFLUENCE THE LOCATION CHOICES
OF HIGH TECHNOLOGY COMPANIES WITHIN REGIONS

Rank	Attribute	Percent Significant or Very Significant
1	Availability of workers:	96.1
	Skilled	88.1
	Unskilled	52.4
	Technical	96.1
	Professional	87.3
2	State and/or local government tax structure	85.5
3	Community attitudes towards business	81.9
4	Cost of property and construction	78.8
5	Good transportation for people	76.1
6	Ample area for expansion	75.4
7	Proximity to good schools	70.8
8	Proximity to recreational and cultural opportunities	61.1
9	Good transportation facilities for materials and products	56.9
10	Proximity to customers	46.8
11	Availability of energy supplies	45.6
12	Proximity to raw materials and component supplies	35.7
13	Water supply	35.3
14	Adequate waste treatment facilities	26.4

Source: JEC, Location of High Technology Firms,
p. 25, table III.6.

Of particular interest to Canadians are the respondents' ratings of Canada as a current and future location as compared to other regions outside the United States. Table 4 shows the ratings of various foreign locations.

TABLE 4
ACTUAL AND PLANNED DISTRIBUTION OF HIGH TECHNOLOGY
PLANTS AND PERMANENT OFFICES BY REGIONS OUTSIDE THE
UNITED STATES, 1981-1986

Regions	(1) Percent Distribution of Existing Plants	(2) Percent Distribution of Planned Plant Additions	(3) Percent Distribution of Planned Plants, 1986	(4) Percent Change in Column 1 & Column 3
Overseas	10.7	14.2	12.2	14.0
Canada	3.5	3.4	3.5	0.0
Latin America	2.2	1.4	1.8	-18.2
South America	1.5	1.2	1.4	- 6.6

Source: JEC, Location of High Technology Firms,
p. 29, table III. 8 (notes omitted).

About these results the authors said:

Another important finding is the apparent lack of interest in Canada, Latin America and South America for expansion. Perhaps the increasingly unfavorable political and business environments in these regions are discouraging high technology entrepreneurs from considering them as a location for their new plants and permanent offices.

Overseas is another matter; their share of high technology plants and permanent offices operated by the survey respondents is expected to rise from 10.7 percent in 1981 to 12.2 percent in 1986, a 14.1 percent increase.⁹

It is beyond the scope of this paper to analyze the possible combination of factors that results in an apparent lack of interest in Canada. The results and their implications for British Columbia in attracting tenants to the Discovery Parks sites have, however, not gone unnoticed.¹⁰ In comparison, the apparent attractiveness of some European locations which can provide "quality labor in abundance" was specifically cited by an industry member during the Urban Land Institute's spring meeting noted above. The speaker commented that many U.S. companies now have a good portion of their labour force in Europe, and that R&D could follow production overseas.¹¹

In the Introduction, the degree of unionization of the British Columbia labour force (approximately 46 percent of all paid workers in 1982) was cited as one obstacle to the establishment of high technology industry in the province. The JEC survey asked respondents for the percentage of their workforces that were unionized, and the impact of unions on choice of location. The study, however, does not report the results for this question. There is a possibility that the majority of respondents indicated "no impact", in which case there would be no results to publish; alternatively, the impact of unions may have been subsumed into other factors such as labour costs or productivity. The study offers no explanation. There is, however, a strong probability

that the number of firms reporting unionized workforces was low, in which case the results may have been considered insignificant in the view of the authors. The U.S. Bureau of Labor Statistics published its first wage survey of the semiconductor industry in 1979. The Bureau reported that approximately one-fifth of the industry's production workers were unionized in 1977, mostly in the Northeast of the U.S.¹² Of the 691 respondents to the JEC survey, 322 were located in California¹³ where the degree of unionization is much less.¹⁴

The results of the JEC survey study can be summarized as follows:

1. High technology companies are "footloose" in their locational choices since access to markets, raw materials and transportation is of lesser importance
2. Accessibility to highly skilled labour (technical, skilled and professional) was found to be the most significant determinant of location
3. Companies were concerned about State and local tax structures because of the effect on the mobility of technical and professional employees
4. High technology companies sought out communities noted for the excellence of their academic institutions, particularly in the sciences¹⁵

Canada

British Columbia Ministry of Industry and
Small Business Development Study

The British Columbia Ministry of Industry and Small Business Development recently commissioned a study to determine how the province compared with other selected jurisdictions as a place for investors wishing to establish new manufacturing businesses, or to expand existing businesses. Although the study, Comparative Business Incentive Study by Arthur Andersen & Co.,¹⁶ was more concerned with an analysis of government incentives, and was not specifically directed at high technology companies, its results do confirm the general findings of the Joint Economic Committee survey.

The MISBD study, which involved a survey questionnaire and in some cases personal interviews, covered 113 companies from Canada (British Columbia, Alberta, Ontario and Quebec) and the United States (Georgia, Colorado, California and Washington). U.S. respondents accounted for 29 percent of the companies surveyed. Twenty-five percent of the respondents were identified as high technology companies.

Among businessmen's perceptions of British Columbia's attractions was "a good supply of both skilled and unskilled labour in the Lower Mainland." Conversely, among British Columbia's perceived weaknesses was "unions in B.C. are militant and detrimental to productivity."¹⁷

The respondents' perceptions of labour in British Columbia are similar to those perceptions discussed in the Introduction. The authors' findings regarding labour were:

1. Labour stability is more important than labour rates

Respondents indicated that stability of labour is more important than the cost of labour. This is true of all the different jurisdictions, industries and sizes of business.

Small businessmen expressed strong anti-union sentiments, based on fear of loss of productivity.

2. B.C. is perceived to be a jurisdiction with labour problems

Businessmen within and outside B.C. perceive the Province as a jurisdiction where labour is militant and therefore less productive and more costly. Respondents indicated that this is well publicized in the mass media, for example many interviewees in Washington and Eastern Canada were aware of the recent B.C. Telephone and CUPE strikes.¹⁸

To counter views such as these the authors recommended that the Ministry of Industry and Small Business Development should publicize comparative facts and figures on labour productivity. In their view, "Current perceptions are probably more damaging to B.C.'s reputation than the facts would be...."¹⁹

While these overall perceptions of British Columbia's labour situation are disturbing, for the purposes of this study the views of the twenty-five percent identified as high technology companies are more germane. Whereas most respondents indicated that proximity to customers was a prime locational determinant, the high technology companies stressed the availability of skilled labour and the quality of life. The latter was actually considered by all respondents to be one of the main attractions of British Columbia as a place to locate or expand. The overall high rating given to quality of life led the authors to recommend emphasis on the establishment and attraction of high technology industry.²⁰

The Prime Determinants For British Columbia

The results of the MISBD study do seem to confirm the findings of the JEC survey — availability of skilled labour is a prime locational determinant for high technology companies. The linkage between the two studies is sufficiently weak, however, to suggest caution on the part of anyone seeking to apply the findings of the more comprehensive U.S. industry study holus-bolus to the situation in Canada in general, and British Columbia in particular.

The JEC study was directed specifically at locational factors for the high technology sector; the British Columbia study focussed on government incentives for all types of manufacturing. Because of the difference in emphasis, the JEC could break down many combinations of factors particular to the specific industry; the MISBD survey dealt with much more generalized concepts. In sum, because the two studies were designed for different purposes, they are not directly comparable. The MISBD report does confirm the importance of skilled labour to high technology companies in comparison to other industries, but it does not confirm the ranking of labour skills as the first locational factor in choosing regions or locations.

What is needed of course is a comprehensive Canadian study of locational determinants. Such a study would reflect the particular facets of the Canadian environment which cannot be contemplated in a survey based on a U.S. framework, particularly in the areas of government regulation and incentives, and tax structure. In the absence of any solid empirical evidence, however, it would be inappropriate to assume that Canadian companies rate locational determinants in the same order as their American counterparts. For the purposes of this study, therefore, although skilled labour is assumed to be a major factor in locational decisions, we cannot ignore the possibility that labour costs or other dimensions of the labour situation in British Columbia may be of equal or greater importance to Canadian high technology companies.

CHAPTER II

LABOUR IN HIGH TECHNOLOGY INDUSTRY

Skills and Shortages

U.S. Labour Profiles

In chapter I, we reviewed the existing empirical evidence that strongly suggests skilled labour is a major, if not prime determinant, in locational decisions of Canadian and U.S. high technology companies. This emphasis on skilled labour, moreover, is consistent with the common attribute shared by high technology firms — the employment of a higher percentage of technicians, engineers and scientists than other manufacturing companies.¹

In 1980, the State of Massachusetts accounted for 6.4 percent of U.S. high technology employment. A survey conducted by the Massachusetts Division of Employment Security analyzed the labour force profiles in high technology companies in June 1980.² Some of those results are illustrated in table 5.

TABLE 5
OCCUPATIONAL PROFILE
NONAGRICULTURAL EMPLOYMENT
MASSACHUSETTS JUNE 1980

Employment %			
Occupational Category	All Nonagricultural	Manufacturing	High-Technology
All Occupations	100.0*	100.0*	100.0 ¹ /*
Managers & Officers	8.2	7.4	8.1
Professional Occupations	15.5	9.4	17.9
Electrical & Electronic Engineers	0.6	1.8	5.2
Technical Occupations	3.5	4.4	9.8
Electrical & Electronic Technicians	0.7	1.7	4.7
Service Occupations	15.1	1.6	1.5
Production & Maintenance Occupations	29.9	61.0	45.4
Electrical & Electronic Assemblers	1.1	4.1	12.3
Clerical Occupations	21.6	13.8	15.9
Sales Occupations	6.3	2.4	1.3

¹/ SIC 376, employing 11,000, is not included due to lack of statistically significant data.

Source: Massachusetts, Massachusetts Division of Employment Security, High Technology Employment: Massachusetts and Selected States, 1975-1981, 2d ed. (Boston, July 1982), p. 23, table 8.

*Columns do not add to 100.0%. Source of discrepancies in original table unknown.

An earlier study of occupational profiles in Massachusetts using 1976 data indicated that within the high technology industry group itself, the proportion of the workforce accounted for by professional and technical employees ranged from a high of 37.8 percent in optical instruments (SIC 383), to a low of 21.9 percent in electronic components and accessories (SIC 367).³ Notwithstanding these high shares for professional workers, however, both Massachusetts studies indicate that the high technology sector is still highly labour intensive, employing a far larger proportion of production and maintenance workers than professionals.⁴

The State of California accounts for the greatest share of high technology employment in the United States - 16.4 percent in 1980.⁵ Much of this employment is concentrated in Santa Clara County, California's famous Silicon Valley. In 1980, approximately 243,000 persons were employed in the manufacturing sector in the County. Over 86,000 persons were employed in the electrical and electronic equipment industry (SIC 36), about half of which were in the semiconductor industry alone (SIC 3674).⁶ The occupational profile for the manufacturing industry in the County reflects the heavy concentration of high technology industry in the area. For 1980-85, the profile is: professional and technical workers - 33 percent;

operators - 26 percent; clerical workers - 15 percent; craft workers - 13 percent; managers, officials and proprietors - 9 percent; sales workers, service workers and labourers - 4 percent. The labour force profile is very similar to that of the Massachusetts industry discussed above.

Canadian Labour Profiles

In 1981, the Ontario Manpower Commission undertook a study on future manpower requirements of the Ontario microelectronics industry.⁷ The study was commissioned by the Ontario Task Force on Microelectronics.

Only companies manufacturing telephone and telecommunications equipment, other communications/data equipment, scientific instruments, computing equipment or electronic components, were included in the study. Firms located in the Ottawa-Carleton region and subject of another study (to be discussed below) were excluded; two-thirds of the 57 companies providing complete information were located in Metropolitan Toronto.⁸ The occupational profile of the companies is presented in table 6.

TABLE 6

EMPLOYMENT FOR SELECTED PROFESSIONAL AND TECHNICAL OCCUPATIONS
IN THE MICROELECTRONICS AND RELATED MANUFACTURING SECTOR,
MARCH 1981

Occupations	Establishments		Employees	
	Number Employing	Percent of Total	Number	Percent Of Total
Electrical and Electronic Engineers	43	75.4	160	5.4
Electronic Engineering Technicians	39	68.4	124	4.2
Electronic Engineering Technologists	36	63.2	101	3.4
Electro-Mechanical Engineering Drafting Technicians	22	38.6	54	1.8
Mechanical Engineers	15	26.3	20	0.7
Mechanical Engineering Technologists	9	16.8	20	0.7
Mechanical Engineering Technicians	5	8.8	12	0.4
Chemical Engineers	2	4	2	0.1
Physicists	2	4	6	0.2
Chemists	1	2	3	0.1
Sub-Total Above	x	x	502	16.9
Production Workers	52	91	1738	58.7
All Other	x	x	723	24.4
Total All Firms and Employees	57	x	2963	100.0

Source: Ontario, Ontario Manpower Commission, Labour Market Research Group,
Professional and Technical Manpower Requirements and Supplies in the
Microelectronics Industry in Ontario: 1981-85, (Toronto, May 1981),
p. 6, table 2.

It is immediately noticeable that the proportion of employment accounted for by production workers in the Ontario survey (58.7 percent) is considerably higher than the equivalent reported for the Massachusetts industry (45.4 percent).⁹ The proportion of professional/technical workers in the Ontario companies is correspondingly lower. These differences between the Ontario and Massachusetts profiles most likely result from the different industry mix in the two studies, but could also reflect more capital-intensive production in the New England firms. The Ontario study, however, also surveyed 24 firms located in Boston, San Francisco and Los Angeles. The authors selected those products "because they manufactured products similar to Ontario firms,...."¹⁰ The occupational profile of these U.S. companies appears to be very similar to that of the Ontario industry rather than the U.S. findings cited above; production workers accounted for 61.3 percent of employment in 1976 and 55.4 percent in 1981. This apparent contradiction of the surveys of Massachusetts and California may be explained by the fact that in reporting the proportion of employment accounted for by production workers and various professional/technical workers in the 24 U.S. companies, the Ontario study omitted "other employees" (clerical, administrative, management)¹¹ from the employment count.

The Ottawa-Carleton area, sometimes dubbed "Silicon Valley North", was the subject of a separate manpower requirement study by the Ottawa-Carleton Industrial Training Council.¹² The value of the occupational profile presented in the study is debatable; the survey included not only the high tech manufacturing companies located in Kanata, but software and consulting firms, and also federal government departments and agencies.¹³ The responding firms (including government) reported total employment of 38,066 persons. Employment was distributed as follows: production - 24 percent; research, development and engineering - 14 percent; administration - 10 percent; marketing - 3 percent; other - 46 percent.¹⁴ The authors report that the high response of "other" as a work activity was accounted for by the inability of some consulting firms and the federal government departments and agencies to categorize the work activity of their employees.

The key question in the survey asked companies to indicate their present and expected employment by academic program. The companies' responses presented in the study have been converted into percentages to give a comparable occupational profile for 1981 in table 7.

TABLE 7

EMPLOYMENT PROFILE

BY ACADEMIC PROGRAM, 1981

Academic Program	Percent of Employment (11,558 Persons)
Electronics Equipment Assembler	9.98
Precision Mechanical Assembler	1.19
Electronics Tester	2.44
Electronics Engineering Technician	15.88
Digital Electronics Engineering Technician	1.55
Electronics Engineering Technologist	11.20
Research and Developer Option	1.05
Mechanical Engineering Technologist	2.73
Industrial Engineering Technologist	- *
Electro-Mechanical Engineering Technician (Drafting)	2.35
Computer Technologist (Computer Science)	8.44
Computer System Technician	- *
Information Processing Certificate	1.77
Business General-Data Processing Option	- *
Business Admin.-Data Processing Option	1.23
Electrical Engineering	21.0
Mechanical Engineering	3.89
Computer Systems Engineering	4.69
Physics	3.29
Mathematics	- *
Combination of Programs	4.96

*Less than 1 percent of employment.

Source: Calculated from Ottawa-Carleton Industrial Training Council, Advanced Technology Human Resource Requirements Survey: High Tech Survey (Ottawa, August 1982), pp. 11-12, table 6.

By academic program, the greatest employment shares were held by electrical engineering, electronics engineering technician and electronics engineering technologist. The substantial weight given to the electrical and electronic specialties relative to other disciplines in the Ottawa-Carleton study is comparable to the heavy weighting these specialties received in the Ontario Manpower Commission study. These studies of the Ontario industry confirm the evidence from U.S. studies of the high dependence of high technology industry on professionals and skilled technologists in the electronics field.

Labour Shortages

The occupational profiles of the Canadian and U.S. high technology industries highlight the sector's dependence on highly skilled professional and technical manpower, especially in the electrical and electronics specialties. At a time when so many people in North America are placing such great faith in high technology as a cure for the current economic ills, however, there has been a growing realization that extreme shortages of skilled labour may thwart further expansion.

Shortages of skilled labour have been the subject of extensive review in both Canada and the United States. Although this paper is more concerned with the problem from the Canadian and British Columbia perspective, it is useful to look briefly at the current situation in the United States. Whereas in Canada the high technology industry is still in a developmental stage, the U.S. industry is relatively mature. The health of the American industry has, moreover, a strategic importance for the United States, once the world leader in semiconductors, in meeting increasing foreign competition.¹⁷

United States

Throughout the extensive literature on the skill crisis in the U.S. industry runs one main theme -- the United States is suffering from a severe shortage of engineers.¹⁸ In 1981, the American Electronics Association appointed a committee to study the engineering shortage and to recommend a plan for action. The Committee's report described the extent of the problem as follows:

The growing shortage of engineers on a national scale threatens to limit the growth of high technology and negatively impact the continued health and vitality of the United States on economical, political, and social grounds.¹⁹

The Association conducted a nation-wide survey on technical employment projections. The results showed that the U.S. supply of electronics and computer engineers would have to be tripled each year from 1981 to 1986 just to meet the demand from the electronics industry alone.²⁰ The National Science Foundation also conducted an employer survey of imbalances in the demand and supply of engineering graduates. The NSF study was not limited to the electronics industry but the results that are reproduced in table 8 confirm the AEA findings of severe anticipated shortages in computing science and electrical, electronic, and computer engineering.²¹

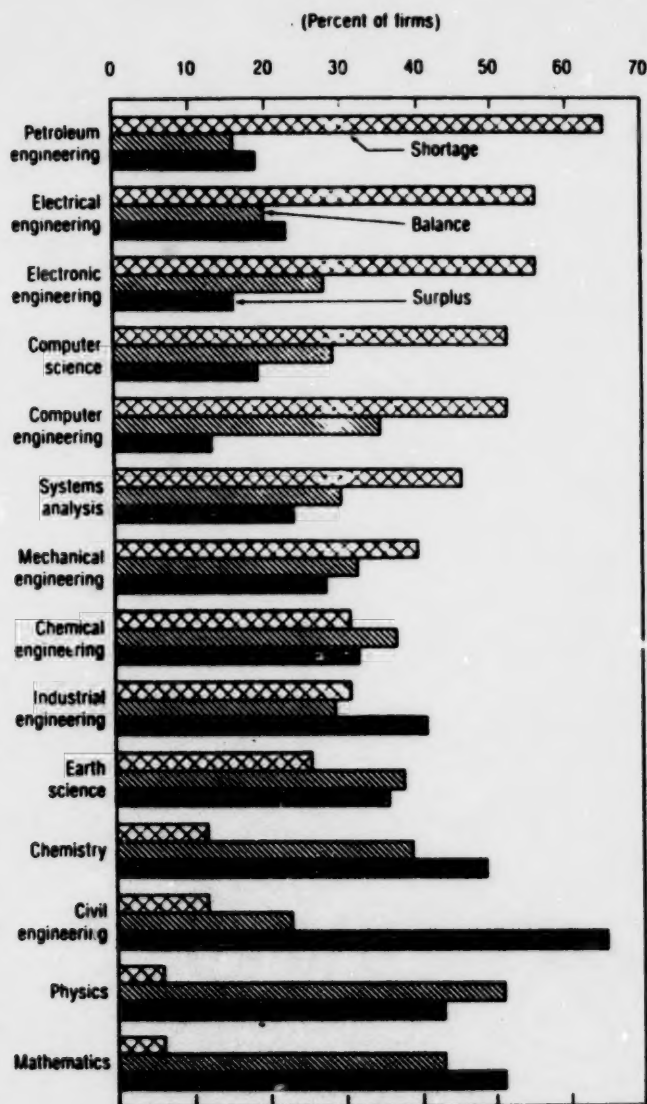
Finally, Doeringer and Pannell cite a vacancy survey conducted for the Massachusetts High Technology Council that reported "vacancy rates for technical professions at 10 percent, with those for electrical/electronic engineers and computer scientists as high as 13 percent."²²

Many reasons are suggested for the shortage of engineers, from the inadequacy of basic mathematics and science instruction in U.S. high schools, to the shortage of faculty in engineering schools. It is beyond the bounds of this paper to speculate further; however, it is obvious that this crisis is becoming more and more apparent to the U.S. industry, educators and all levels of government.²³ The

TABLE 8

RESULTS OF NATIONAL
SCIENCE FOUNDATION SURVEY

Science and engineering fields by proportion
of employers reporting shortage, balance, and
surplus of new graduates: 1981



*Excludes Ph.D.'s
SOURCE: National Science Foundation

Source: Canadian Council of Professional Engineers,
"Surveys and Statistics", Engineering Manpower News,
No. 36 (September/October 1983), p. 2, table II.

AEA study recommended that the industry set a standard for aid to education at 2 percent of R&D expenditures. Some state governments are also channelling funds into engineering.²⁴ The recent emergence of a group of U.S. Congressmen who have promoted various "high tech" bills since January of this year has forced the Reagan Administration to reverse its previous opposition to increased education funding.²⁵

Canada

A shortage of engineers has also been observed in Canada. In a recent study, the Ministry of State for Science and Technology estimated that by 1985 requirements for engineering graduates on a national level would exceed supply by 12,400 persons.²⁶ Historically, Canada has been able to meet its requirements through immigration. Since 1976, however, immigration of engineers in all specialties has decreased dramatically to the point where this country can no longer depend on a surplus of foreign-trained manpower.²⁷ At the industry level, the MOSST study identified the electronics and electrical industry as one of the sectors likely to experience severe engineering manpower shortages.

Ontario

The severity of the engineering shortage for the high technology sector in Ontario is more markedly borne out by the work of the Ontario Manpower Commission. The Commission estimated employment of electrical and electronics engineers in the Ontario microelectronics industry would increase by 1400 from 1981 to 1985. At the same time, approximately 2790 graduates from Ontario universities in these disciplines would be available to the provincial labour market. The microelectronics industry was employing about 12 percent of the total electrical/electronic engineers; the projected requirement to 1985 represented 50 percent of all new Ontario graduates available to the labour market. The Commission concluded that the Ontario industry would be unable to meet its demand for electrical and electronic engineers unless other sectors had lower requirements in the future. The study also reported projected serious imbalances in the demand and future supply of engineering technicians and technologists from Ontario community colleges.²⁸

The findings of the Ottawa-Carleton Industrial Council were similar. The most severe hiring difficulties reported were for computer systems engineering, electrical engineering and computer technologists.²⁹

British Columbia

The Association of Professional Engineers of the Province of British Columbia estimates there are approximately 1780 electrical engineers registered in the province. This figure includes people working out-of-province and retired and life members; it does not measure employment.³⁰ Employment and Immigration Canada produces two year projections of occupational demands and supplies in its Forward Occupational Imbalances Listing (FOIL); the March 1983 FOIL lists estimated employment of electrical engineers as 2570.³¹ Although employment figures are preferable the Association estimates have been chosen rather than the FOIL listing for two reasons. First, the Ontario Manpower Commission study utilized estimates supplied by the Association of Professional Engineers of Ontario; secondly, the discrepancies between the FOIL estimates of employment in some engineering specialties and the distribution of registration by specialty with the Association cause some concern.³²

The Faculty of Engineering at the University of British Columbia provided figures on engineering graduates since 1969-1970. This information is summarized in table 9.

TABLE 9
UBC UNDERGRADUATE ENGINEERING DEGREES
AWARDED, 1969-1983

	Total Degrees	Electrical	Electrical as Percent of Total
1969-70	234	66	28.2
1970-71	243	70	28.8
1971-72	236	69	29.2
1972-73	237	63	26.5
1973-74	221	40	18.1
1974-75	186	47	25.2
1975-76	179	52	29.1
1976-77	192	51	26.6
1977-78	197	66	33.5
1978-79	255	55	21.6
1979-80	267	72	27.0
1980-81	313	79	25.2
1981-82	215	74	34.4
1982-83	315	82	26.0

One can see from table 9 that the proportion of total degrees accounted for by the electrical specialty has been fairly constant over the years. There seems to be no clear trend towards an increase in this particular branch of the profession despite supposedly brighter employment prospects for electrical engineers as compared to others.³³

In the absence of a survey similar to the Ontario Manpower Commission study, is there any way of estimating the demand for electrical engineers by high technology companies in British Columbia?; does this province face the possibility of a manpower shortage similar to Ontario? By using the figures on the supply of engineers provided by the Association and the University of British Columbia and by applying Ontario/British Columbia ratios, we have attempted to measure demand. The reader is cautioned, however, — any inferences are highly speculative.

There are approximately 14,700 registered electrical engineers in Ontario³⁴ and 1,780 in British Columbia. This gives a ratio of approximately 8:1. The ratio may appear at first to be extremely high in Ontario's favour given the ratio of the populations — in January 1983, Ontario had a population of approximately 8.7 million and British Columbia a population of 2.8 million; however, in relation to the different structures of the provinces' economic bases, it does not

appear unreasonable. Ontario has about seven persons employed in manufacturing to every one person similarly employed in British Columbia. The Ontario study estimated projected requirements for electrical engineers by the microelectronics and related manufacturing sector during 1981-85 as 1400. If one can assume that the engineering ratio of 8:1 will remain constant, and further that British Columbia companies would have exactly the same (relative) requirements as Ontario firms, the projected requirements for British Columbia would be $1400 \div 8$ or 175 electrical engineers from 1981-85.

From table 9, we can see that UBC awarded 234 undergraduate degrees in electrical engineering from 1981 to the spring of 1983. Since the trend in electrical engineering graduates is fairly constant, let us assume for 1983-84 and 1984-85 another 165 graduates, to give a total of 400. If all these graduates remained in British Columbia, the estimated requirements of the British Columbia industry (i.e., 175) would represent 43.75% of all electrical engineering undergraduate degrees awarded from 1981-85. The 43.75% overstates requirements to the extent that the figures include post-graduates; conversely, the 43.75% understates domestic requirements because not all engineering graduates from UBC will be available to the provincial labour force. As was said above, any inferences drawn from these figures are highly speculative because the assumptions are questionable. There is no indication that British Columbia companies

would hire at the same rate as Ontario companies or that their labour force profile requirements would be identical.

The new Faculty of Engineering at the University of Victoria will be adding to the province's supply of engineers in the future. In a recent article in The B.C. Professional Engineer, W.C. Van der Straeten analyzed the ability of UBC to produce engineers, and concluded that the single institution had the capacity to produce sufficient graduates.³⁵ And in an earlier article, D.T. Holloway concluded from analyzing the history of registration of UBC engineering graduates with the APEBC that there was a surplus.³⁶ To the extent that high technology development in British Columbia is hindered by a shortage of engineering talent, the phenomenon may only be short run. Moreover, it is likely that despite the decrease in immigration of foreign-trained engineers to Canada, this province could continue to attract out-of-province engineers (whether Canadian trained or not) if employment opportunities were to rebound out of the current recession because of British Columbia's superior quality of life.³⁷

Whereas British Columbia may not be facing an acute shortage of engineers, the outlook for other skilled labour -- engineering technologists -- may not be as promising. In 1980, the Ministry of Education commissioned a study on technological training in engineering, health science and related fields.³⁸ Using information

from the Society of Engineering Technologists of British Columbia, the study concluded that the post-secondary education system was producing technologists only slightly in excess of maintenance. The system could not accommodate growing demands by industry in the engineering field.³⁹ Employment and Immigration Canada, while recognizing relatively low demand during the recession, now says that shortages are expected to reoccur quickly as the economy returns to growth with substantial shortages in the electrical, and electronic fields.⁴⁰

Shortages in this field could have serious repercussions for the development of high tech industry in the province. The JEC's research suggested that skilled technical workers are less mobile than professionals.⁴¹ If such is also the case in Canada, British Columbia companies may have difficulty attracting technologists from other regions. The JEC study also concluded that the availability of in-place technical workers was a more important locational determinant than the supply of professionals.⁴² If a greater domestic supply of technicians and technologists is not forthcoming from the provincial educational institutions, out-of-province companies may be deterred from establishing plants in British Columbia. In the face of this skill shortage, however, it is encouraging that increased technical training is currently under study by the Ministry of Labour and

Employment and Immigration Canada.⁴³ The Science Council of British Columbia has also recommended increased support for technical training.⁴⁴

Wages and Costs

Wage Costs in British Columbia

The Joint Economic Committee study reported that wage costs were ranked as the second most significant locational determinant for high technology industry after the availability of skilled labour.⁴⁵ Given the relatively high percentage of production workers which still makes up the "high tech" labour force despite its "professional" image, this ranking is not surprising.⁴⁶ Wage rates for production workers can be viewed as an important determinant not only for locational decisions but also for the long-run economic viability of the industry, especially an industry faced with increasing international competition from the so-called "low wage countries".

British Columbia is a high wage province. Table 10 shows average weekly wages and salaries for selected provinces. British Columbia earnings are the highest in Canada. British Columbia also ranks first in average hourly earnings in manufacturing which are shown in table 11.

TABLE 10

AVERAGE WEEKLY EARNINGS, SELECTED PROVINCES (DOLLARS)
EX. PUB. ADMIN

	CANADA	ONTARIO	ALBERTA	B.C.
Jan. 1982	377.44	370.02	412.99	431.31
Dec. 1982	398.69	389.11	445.13	448.49
Jan. 1983	405.13	395.80	455.82	464.15

Source: British Columbia, Ministry of Industry and Small Business Development, British Columbia Earnings and Employment Trends ([Victoria, B.C.]: MISBD, May 1983), p. 11, table 2.2.

TABLE 11

AVERAGE HOURLY EARNINGS, MANUFACTURING
SELECTED PROVINCES (DOLLARS)

	CANADA	ONTARIO	ALBERTA	B.C.
Jan. 1982	9.86	9.75	11.26	13.27
Dec. 1982	10.62	10.48	12.31	14.68
Jan. 1983	10.69	10.51	12.38	14.83

Source: Statistics Canada, Employment, Earnings and Hours, 72-002 (April 1983), p.5.

The manufacturing sector in British Columbia employed an average of 156,000 people in 1982; about 66 percent of these workers were unionized. Manufacturing is the third largest employer in British Columbia after services and trade, but ranks only fifth out of eight sectors in earnings.⁴⁷

Much of the criticism of labour and unions in British Columbia, which was discussed above in the Introduction, was directed at the effect of unionization and provincial labour law on industrial relations and labour stability. It is not the purpose of this study to argue for or against changes in the British Columbia Labour Code. One cannot ignore, however, the direct effect of unionization on wage rates in manufacturing in this province. Manufacturing wages are on average higher in British Columbia than anywhere else in Canada, and these costs must affect the competitive positions of existing firms and the locational preferences of potential new entrants. The level of wages becomes more critical when one examines the trend in the more mature high tech industry in the U.S. for many companies to seek out lower wage jurisdictions. Even now there are indications of this trend appearing in Canada with the recent announcement by Nabu Manufacturing of the closing of its Almonte, Ontario manufacturing facility, and of its desire to locate in low-wage countries.⁴⁸ The resulting lay-offs have stimulated renewed attempts by the Communications Workers of Canada to organize Nabu production workers.⁴⁸

Wage Costs in U.S. High Technology Companies

The most recent and comprehensive survey of wages in the U.S. high technology sector is contained in the 1982 report of the Massachusetts Division of Employment Security. The range of 1980 annual earnings in the 25 states surveyed was from a low of \$12,600 in Maine to a high of \$21,150 in Michigan. In all but seven states, average annual high tech wages were higher than average annual wages for all manufacturing.⁴⁹ This relationship would seem to confirm evidence cited by Doeringer and Pannell in their study of the New England industry that "production and clerical workers, for example, are relatively better paid than their counterparts in many other industries."⁵⁰ The State of North Carolina, location of the well-known Research Triangle Park, is a case in point. According to the Massachusetts survey, in 1981 average annual wages for North Carolina were: all industries - \$12,400; manufacturing - \$12,920; high tech - \$20,965.⁵¹

In 1980, Michigan had the highest annual wage rates for all industries, manufacturing and high tech; however, the relationship discussed above was reversed. Manufacturing wages were \$23,060 whereas high tech earnings were \$21,510.⁵² One may be seeing in this instance the effect of the existence of a dominant union, the United Auto Workers, whose rates pull up the absolute level of all wages while acting as an umbrella or limit price for labour in the state. To some extent, forest industry unions' rates may have the same effect on wage levels in British Columbia.

As the authors of the Massachusetts study point out, the wage figures include both hourly-rated and salaried workers, and all bonuses. The data does not measure hourly earnings (which may be a better indicator for production workers), but does indicate trends or relationships.⁵³ Given these caveats, the ranking of the 25 states is contained in table 12.

The significance of the wage ranking of any particular state may not be apparent until it is weighted by those other locational factors identified in the JEC study. As discussed in chapter I, a combination of high labour cost and restricted availability of skilled labour, high taxes and congestion is creating the spatial dispersion of the U.S. industry away from the New England and the West.⁵⁴

A far more disturbing trend is the location of more and more labour-intensive production capacity (assembly operations) outside of the United States. This tendency of course is not restricted to the so-called high technology sectors. For many years, U.S. multinational corporations have sought out foreign locations with an abundance of cheap, unskilled labour to assemble various consumer products (e.g., digital watches, calculators, radios, TVs). In addition, an international division of labour has long been

TABLE 12
AVERAGE ANNUAL WAGE HIGH TECHNOLOGY INDUSTRIES
RANKING OF SELECTED STATES, 1980

STATE	RANKING
Arizona	8
California	5
Colorado	3
Connecticut	11
Florida	14
Georgia	23
Illinois	18
Maine	25
Maryland	6
Massachusetts	12
Michigan	1
Minnesota	9
Nevada	21
New Hampshire	20
New Jersey	4
New York	2
North Carolina	19
Ohio	13
Pennsylvania	10
Rhode Island	22
Texas	16
Utah	24
Vermont	7
Virginia	15
Washington	17

Source: Massachusetts, High Technology Employment,
p. 22, table. 7.

characteristic of the U.S. semiconductor industry. In the JEC study of international competition, the authors estimated that approximately 80 percent of all U.S.-based wafer fabrication (the most technically difficult and highest value-added stage of IC production) took place in the United States. In contrast, not more than 20 percent of assembly operations took place in the U.S. but rather was conducted by the U.S. companies in their affiliates in Latin America and Southeast Asia.⁵⁵

In February 1983, Atari, Inc. announced that it was closing its Sunnyvale, California plant and moving the assembly of its video games and home computers to Hong Kong and Taiwan. Seventeen hundred Atari workers were to be laid off. Some sources estimated Atari would be paying the foreign workers only \$1.00-\$2.00 per hour as compared to approximately \$9.00 per hour in California.⁵⁶ The closing of the Atari plant simply highlights the difficulties high-wage countries and regions have in keeping or attracting high technology assembly plants. British Columbia with its higher than average wages faces just such a problem. The employment expected to be generated by the high tech revolution may, therefore, not be forthcoming in the face of competition from low-cost foreign labour. High tech may simply not be the solution to the economic ills of North America's traditional manufacturing industries nor the cure for substantial unemployment. Chapter III offers some thoughts on these prospects.

CHAPTER III

LABOUR AND THE HIGH TECHNOLOGY FUTURE

Competition for High Technology Industry

The Scramble to Attract Industry

"High technology industry" is now lauded throughout North America as the cure for the economic ills of the 1980s; as a means of revitalizing decaying "smokestack industries"; as a source of new jobs for millions of workers previously employed in traditional manufacturing. Hardly a day passes when one does not read of another state, provincial or local government body announcing new programs to attract "high tech" to its particular region.

British Columbia's advanced technology programs have been mentioned in the Introduction. More recently, in the provincial budget of July 7, the government announced a new approach to industrial assistance programs. The Ministry of Industry and Small Business Development will be emphasizing the provision of risk capital to high technology ventures.¹ In January 1981, the Government of Ontario announced a new five-year program - BILD (Board of Industrial Leadership and Development). The program included the establishment of six high technology centres in the province: the Ontario Centre for Microelectronics in Ottawa; a CAD/CAM centre in Cambridge;

a robotics centre in Peterborough; resource machinery, Sudbury; auto parts technology in St. Catharines; and farm equipment/food processing in Chatham.² The federal budget of April 19, 1983 set aside a sum of \$700 million for technology development. Later announcements by the federal Minister of Science and Technology outlined the projects to be undertaken including development of a national biotechnology strategy, development of a national microelectronics sector and the construction of 12 new research and training centres. Initial industry reaction to the federal announcements was positive although some speculated that the \$700 million commitment was only one-fourth of what was needed.³ The governments of Quebec, Saskatchewan and Alberta have also indicated their intentions to introduce programs to assist high technology investment.

In the United States, competition for high technology industry is even more fierce. It has been estimated that there are 4,500 economic development agencies in the U.S., all seeking to attract "high-tech".⁴ Encouraged by the success of ventures such as North Carolina's Research Triangle Park (RTP), countless cities and states are embarking on programs offering tax breaks, research parks and venture capital in efforts to attract industry. These programs are too numerous to relate in this paper, but as a recent article in BusinessWeek commented, "Every state and city plans to make it big."⁵ Whether these big plans will work is another matter.

Prospects for Success

A slow sort of country! said the Queen. Now, here, you see, it takes all the running you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!⁶

In the current scramble to entice high technology industry, the Queen's admonishment to Alice is well worth heeding. Successful ventures such as RTP mentioned above have taken years to develop -- 27 in the case of North Carolina; some latecomers are bound to fail by the wayside. Many cities, states and regions will be unable to offer that combination of locational factors -- critical mass -- attractive to high technology industry. The competition for these industries is so fierce that even a host of inducements cannot attract companies to some less-desired areas.⁷ Moreover, even those areas which do attract companies may find that the new industry does not generate the expected increases in employment; the push for high tech may not alleviate massive unemployment in traditional manufacturing. Labour is crucial to both of these considerations. How labour in British Columbia fits into this scene must now be examined.

Labour Factors in B.C.'s High Tech Future

Labour and the Attraction of Industry

The Joint Economic Committee study discussed in chapter I identified the availability of skilled labour as the prime determinant of locational decisions of high tech companies; labour cost was ranked second. For our purposes, we assumed labour skills as a prime factor for British Columbia although we acknowledged the lack of any empirical study of Canadian companies.⁸

In chapter II, we examined labour skills and shortages, and wage costs in the province in an attempt to get some idea of the value of the labour factors in British Columbia. Our review suggested that British Columbia may not suffer from an acute shortage of electrical and electronic engineers in the long run; that the province was likely to suffer from a shortage of skilled engineering technologists; and that wage rates in British Columbia were on average the highest in Canada.

In the absence of any weighting for other locational determinants, the high tech labour skills profile for British Columbia indicates that industry would be attracted by the existence of skilled engineering professionals and would be deterred from locating by the

lack of trained technologists. The weighting given to the skill factor would tend to be neutral. The high wage rates would certainly be a negative factor. These weightings have definite implications for the type of high tech industry that could be attracted to the province, for overall employment and for future public policy.

The labour skills/costs profile for the province suggests that British Columbia could probably attract industry based on a small cadre of high-skilled professionals (e.g., engineers/computer specialists) most likely utilizing sophisticated CAD techniques in day-to-day operations. There appears to be every indication that British Columbia offers those particular "quality of life" factors necessary to attract and maintain a good supply of professional labour.⁹

The shortage of trained engineering technologists suggests that those companies contemplating location in this province must be either companies willing to train existing workers in new skills, or to utilize automation as a replacement for relatively scarce (and therefore costly) technical labour. Training of new technologists and retraining of existing workers have important ramifications for public policy. These ramifications will be discussed below.

The levels of wage rates in British Columbia, and for that matter in the rest of Canada, are by every indication too high to support large-scale manufacturing which could be competitive in the world market. This view was expressed by the chairman of the Canadian Advanced Technology Association, William Hutchison, who also said, "There's no question that when companies [microelectronics] get into volume production, they will seek lower cost manufacturing (overseas)."¹⁰ The only alternative in the Association's view is the extensive use of robotics as a substitute for costly Canadian labour. And whereas the use of robotics may create some skilled jobs for robot operators, it does not generate any considerable domestic employment.¹¹ Highly labour intensive manufacturing operations are therefore not likely to locate in British Columbia because of the cost of labour. Whether a highly automated manufacturing operation would locate in this province depends on a host of other factors such as tax incentives and subsidies for training.

High Tech Employment Prospects for British Columbia

In this paper, many references have been made to popular thinking that high technology industry will revitalize North American manufacturing and create jobs for large numbers of unemployed workers from decaying traditional industries. Recent commentaries on the employment prospects of the high tech industry offer a much less optimistic view.

In the United States, it is estimated that the industries identified by the Bureau of Labor Statistics as "high tech" will generate only 730,000 to 1 million jobs over the next 10 years, less than half of the 2 million jobs in U.S. manufacturing that have disappeared over the last 3 years. While the greatest proportion of the new jobs created will be for the less-skilled worker, the most rapid growth in jobs will be for professionals and skilled workers.¹² A similar prediction is made for Canada. According to the CATA, only 25 percent of jobs in Canadian high tech companies are accounted for by semi-skilled workers. If Canadian industry succeeds on an international scale, this proportion is bound to decline.¹³ Whether semi-skilled workers are replaced by robots or whether labour - intensive assembly operations are moved overseas, the net result is the same -- fewer employment opportunities for unskilled labour.

The high tech revolution cannot be considered a solution to the unemployment problem among less-skilled workers or unemployed workers in stagnant industries.

Retraining laid-off workers in a region could supply new high tech companies with the required skilled labour force; such an option was suggested above in connection with this province's shortage of technologists. Whether such a scheme would work in British Columbia

is debatable. An official with the United Auto Workers notes that unemployed auto workers are not signing up for a General Motors sponsored retraining program because high tech jobs do not pay as well as the auto industry. High tech jobs are considered menial and demeaning by many auto workers who still hope to return to their old jobs.¹⁴ Such sentiments could very well be shared by unemployed workers from British Columbia's high-wage resource sector.

Public Policy Implications

Costs to Government: Subsidies and Trade-offs

Our analysis of labour factors in the development of high technology industry in British Columbia raises important public policy issues. These issues have implications for future education, employment and industrial development policies of the provincial government. They also involve basic considerations about the extent to which government should intervene in the marketplace, about the amount of financial assistance that should or can be provided in times of severe fiscal restraint, and about the trade-offs between assistance to an infant industry and other pressing socio-economic needs. In this paper, we can only raise some of these issues. Further research is obviously required in developing a comprehensive public program for high tech industry.

If we accept initially the premise that high technology industry must be encouraged to locate in the province, we are immediately faced with the identifiable labour shortage of skilled engineering technologists and technicians discussed in chapter II. The shortage must be alleviated by increased training of new students, retraining existing workers or some combination of both. Training of a greater number of new technology students will require additional educational facilities and thus increased government expenditures on education. The implications of increased technological education were discussed thoroughly in the 1981 British Columbia Ministry of Education Task Force Report.¹⁵ Retraining of the unemployed is another source of skilled labour. As pointed out above, however, unemployed workers from high wage industries in the U.S. have shown little interest in such schemes.

Implicit in most discussions about the training of new technologists and the retraining of existing workers is the assumption that government must bear the cost. The Science Council of British Columbia recommended in its 1982 report A Research and Development Policy for British Columbia in the Eighties that "the government should increase support for programs aimed at the training of highly qualified manpower," and that "the province should ensure that there is an adequate supply of trained scientists and technologists...."¹⁶

The Canadian Advanced Technology Association has said that "tax breaks and retraining subsidies...would help Canadian companies."¹⁷

In November 1982, the Electrical and Electronic Manufacturers Association of Canada, the federal Department of Industry, Trade and Commerce and the Canada Employment and Immigration Commission signed a Memorandum of Understanding aimed at alleviating labour shortages in the industry. It is estimated that the federal government will cover between 40 to 80 percent of training costs.¹⁸

Government subsidies for training in high technology skills appear to be generally accepted; however, some concerns have been raised. The Fraser Institute has criticized these subsidies because of their distributional effect, that is the redistribution from low-income taxpayers to high-income taxpayers.¹⁹ Moreover, since high technology industry is unlikely to generate substantial numbers of jobs for those currently out of work, if employment is the goal, the subsidies might better be directed elsewhere. In times of severe fiscal restraint, considerations as to where to direct scarce government resources become even more crucial.

We have accepted initially (as discussed above) the premise that high technology industry should be encouraged to locate in British Columbia. Programs designed to attract skilled labour and to upgrade the skill level of the existing work force would be a necessary part

of public policy. We must now consider however the basic assumption -- does British Columbia's economic future lie with "high tech".

Is High Tech Right for British Columbia

The main question to be considered is: does high tech really offer the best prospects for future economic growth and increased employment given the basic structure of the provincial economy?

As discussed above, high technology industry is not likely to generate dramatic increases in direct employment in British Columbia because of increasing automation (robotics) and competition from low-wage countries. Any substantial increases in the number of jobs will be from spillover effects. The application of high technology products to operations in other industries may generate more employment and greater productivity than the forced creation of the industry itself. This view has been most eloquently expressed by the Association of Professional Engineers of British Columbia in a recent submission to the provincial government. The Association said:

There is concern among many engineers that "high technology" is perceived by politicians, government officials and the public alike to be synonymous with electronics, computers, silicon chips and similar endeavours, to the detriment of many other equally valuable technologies which involve the use, rather than the production, of advanced electronic technology.

High technology has been with us for decades. Such developments as the modern automobile, television, jet engine, computer and satellites are all high technology. So are the thin-kerf bandmill, log yarding crane, log chipper, rubber-tired skidder, kraft pulp mill and open pit mine.²⁰

The government in the Association's view, should strive for "a balance between incentives provided for the so-called 'high technology' and for many other manufacturing opportunities which have as much or more potential for creating employment for British Columbia's labour force."²¹ The Association's view is the most succinct expression of concern about this province's joining the "high-tech bandwagon". And it is in the author's opinion the major public policy decision that must be made by government.

Can British Columbia Meet the Competition for High Tech Industry

Assuming that government does make a conscious decision to seek out more and more "high tech industry", can British Columbia compete successfully against the thousands of other agencies and governments across North America, all eager to attract this industry.

This study has concentrated on the role that labour plays in the locational decisions of high technology companies. Labour of course is only one factor. To compete successfully, British Columbia must show that it offers the critical mass - that particular combination of factors necessary to this industry. Already there are

indications in the United States that many of the estimated 4,500 agencies and governments chasing high tech will not succeed.²² Now too in Canada, just as the provinces of Alberta and British Columbia have announced intentions to launch domestic chip manufacturing, comes a warning to the federal government that its assistance to high tech industry should not be spread thinly across Canada just for political reasons.²³ In a report to the federal government, the Commercial and Industrial Development Corporation of Ottawa-Carleton warned that the Canadian industry was small on a world scale and very fragmented; that the country could not afford to disperse the existing industry to solve problems of regional disparity; and that existing centres such as Ottawa-Carleton must receive primary attention in order to reach critical mass.²⁴ If the industry is concerned that the development in the Ottawa-Carleton area has not reached world-scale proportions (it is still an infant industry), what prospect for success is there for British Columbia, Alberta and other provinces whose industries are only in the embryonic stage? In the face of fierce competition across the continent to attract high tech industry, in the face of severe fiscal restraint in government, British Columbia may only be able to offer too little, too late. A recognition of this possibility must underlie every public policy decision.

Conclusions

Overview and Suggestions for Further Research

In the Introduction, it was stated that this study was an attempt to determine the role of labour in locational decisions of high tech companies against a background of generalized statements about labour in British Columbia.

The 1982 study by the Joint Economic Committee, reviewed in chapter I, reported that high technology companies rated labour skills and availability as the prime locational determinant; labour costs were second. Those views were indirectly confirmed in a study by the British Columbia Ministry of Industry and Small Business Development. It was assumed for this analysis that labour skills was a prime determinant for British Columbia. There is no empirical evidence, however, indicating that Canadian companies rank factors in the same manner as U.S. firms.

Chapter II reviewed high technology labour profiles in U.S. and Canadian companies, skill shortages and labour costs. The analysis concluded that British Columbia may not suffer an acute engineering shortage in the long run but that the province lacked technicians and technologists. Wage rates in British Columbia are on average the highest in Canada. Such a level of wages is a positive disincentive to the location of labour-intensive manufacturing operations in the province.

The labour skills profile and wage level in British Columbia suggested that high tech companies most likely to be attracted would be those who substitute capital (CAD/CAM, robotics) for labour. Such companies would not generate substantial increases in direct employment. These conclusions have important public policy considerations including the value of government subsidies for training, and the question as to whether high tech industry should be encouraged as an end in itself. Finally, the position of British Columbia as a competitor for high tech industry was reviewed. Competition is so severe that provincial inducements may not be sufficient to attract industry to the province.

This study also suggested many areas requiring further research. In particular, an empirical survey of locational determinants for Canadian companies is sorely needed. Too often one is required to translate the American experience into our own. In addition, a complete picture of the highly skilled labour profile in British Columbia is not possible without more complete and accurate surveys of the numbers of professional engineers available for work (rather than just registered) in British Columbia. The Employment and Immigration figures do not elicit complete confidence. Finally, a survey of labour profiles in British Columbia high tech companies

would give a more appropriate picture of the industry, and would relieve the researcher from relying on foreign material such as the Ontario Manpower Commission study.

A Final Comment

This study was designed to examine the role of labour in the establishment of high technology industry in British Columbia. It has in fact only looked at a few dimensions of the labour factor: skills, supplies and costs. Just as other dimensions regarding labour come into play -- the role of unions, legal constraints -- so do a whole host of other locational factors when one examines the dynamics of this exciting industry. More than any other conclusion drawn from this research, however, the author believes the province must not be caught up into the scramble to attract high tech as an end in itself. An industry consultant recently said:

We can't try to create just a high-tech industry for its own sake. Just as important is stuffing the new technology into resource, chemical, forestry and the rest of the old guard. Those industries' acceptance of technology is as important as the technology itself.²⁵

The application of high technology to British Columbia's more traditional industries may offer the prospect of a brighter economic future than can be achieved by growing a Silicon Valley of our own.

APPENDIX

LOCATIONAL CRITERIA FOR U.S. AND JAPANESE ELECTRONICS COMPANIES

In this paper, the study done for the U.S. Joint Economic Committee on locational determinants of high technology industry was relied upon heavily. The JEC survey was limited to companies operating in the United States. In 1978, the consulting firm of Booz•Allen & Hamilton undertook a study of international investment in electronics for the Scottish Development Agency.¹ As part of the study, the location selection criteria of U.S. and Japanese companies were compared. The results of that comparison are shown in table 13.

Both U.S. and Japanese companies placed great weight on local availability of specialized labour. Japanese companies placed greatest emphasis on high standards of labour performance and on the attitude of the "host" government. In comparison, U.S. companies were more concerned about labour costs and avoiding organized labour environments.

In 1983, Booz•Allen's London office published another study entitled Electronics Industry Investment Dynamics: Trends in the 1980's. They reported that by 1981 the relative importance of specialist labour and the attitude of the host country had increased substantially for U.S. companies evaluating overseas investment.

In addition, the location of R&D facilities to tap international knowledge pools and to take advantage of overseas R&D incentives was becoming as important as the location of manufacturing facilities.² In contrast to 1978, Japanese companies had increased their weighting of labour productivity and quality of local component supply.

Although the Booz-Allen studies dealt with locational criteria for overseas investment rather than domestic expansion, the results do reinforce the importance of skilled or specialist labour as a locational determinant.

TABLE 13

Relative Importance of Location Selection Criteria
to US and Japanese Companies

Location Selection Criteria	Relative Importance Attached by:	* US Companies o Japanese Companies
Political/economic stability	***** oooooooo	Japanese companies less afraid of managing within an uncertain political and economic environment
Labor cost	***** oooooooo	US companies emphasize labor cost whilen...
Labor performance	***** oooooooooooooooooooo	...Japanese companies emphasize performance
Labor organization	***** oooooooo	US companies less confident and willing to work in an organized labor environment
Availability of specialist labor	***** oooooooooooo	Both US and Japanese companies emphasize local availability of specialist skills with less concern for untrained labor
Availability of untrained labor	***** oooooooooooo	
Attitude of host government including incentives	***** oooooooooooooooooooo	Japanese companies emphasize their need for a welcome from the host government...
Infrastructure, particularly supply	***** oooooooooooooooooooo	...and their concern for a sound infrastructure, particularly supply
English-speaking	***** oooooooooooo	US companies now place less emphasis than the Japanese on an English- speaking location
Weighted Value		

Source: Booz.Allen & Hamilton Inc., International
Investment in Electronics (London, [1981]),
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NOTES

INTRODUCTION

- ¹ The Science Council of Canada is one of the major proponents of this theme; see, e.g., The Weakest Link: A Technological Perspective on Canadian Industrial Underdevelopment, by John W.H. Britton and James M. Gilmour, Background Study 43 (Ottawa: Minister of Supply and Services Canada, 1978); Forging the Links: A Technology Policy for Canada, Science Council of Canada Report 29 (Ottawa: Minister of Supply and Services Canada, 1979).
- ² A comprehensive bibliography on this subject is contained in Stephen G. Peitchinis, The Effect of Technological Changes on Educational and Skill Requirements of Industry, Industry, Trade and Commerce Technological Innovation Studies Program Research Report No. 45 (Ottawa: IT&C, April 1978), pp. 207-72; see also, Heather Menzies, Women and the Chip: Case Studies of the Effects of Informatics on Employment in Canada (Montreal: The Institute for Research on Public Policy, 1981), and Labour Canada, In the Chips: Opportunities, People Partnerships, Report of the Labour Canada Task Force on Microelectronics and Employment (Ottawa: Minister of Supply and Services Canada, 1982).
- ³ See Peitchinis, The Effect of Technological Changes, and Technological Changes and the Demand for Skilled Manpower in Canada, Industry, Trade and Commerce Technological Innovation Studies Program Research Report No. 67 (Ottawa: IT&C, January 1980); see also, Economic Council of Canada, In Short Supply: Jobs and Skills in the 1980s (Ottawa: Minister of Supply and Services Canada, 1982).
- ⁴ "Government Salary Aid Urged for New High-Tech Industries," Globe and Mail, 18 March 1983, Report on Business, p. B13.
- ⁵ "High-Tech Wars into New Phase," The Sun (Vancouver), 9 May 1983, p. H1.
- ⁶ "Labor Shield Said Crucial to High Tech," The Sun (Vancouver), 9 May 1983, p. B8.
- ⁷ Of course, the lack of empirical research on the Canadian industry is not surprising given its relative immaturity.

- 8 By labour, we do not in this instance mean individual workers but rather the whole environment including wage rates, skills, the structure of the labour force, the degree of unionization, and the legislation covering labour and management practices.

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- 4 Ibid., pp. 49-55.
- 5 Ibid., pp. 18-19.
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APPENDIX

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